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STUDIES OF GAPS IN SUGARCANE ROWS AND THEIR EFFECT UPON YIELD UNDER LOUISIANA CONDITIONS

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INTRODUCTION

Under conditions prevailing in southern Louisiana, a continuous stand of sugarcane is not ordinarily obtained. Quite generally an appreciable percentage of the row space comprises gaps of different lengths, the prevalence of which depends on a number of factors. Most of the gaps originate either in the plant cane or second-year stubble, but occasionally a very weak variety, such as P. O. J. 234, will show a fairly high increase of gaps in first-year stubble.

The extent of gaps found in a given field of sugarcane is usually the deciding factor as to whether it is to be plowed out or retained for further cultivation. Under conditions of greatly impaired plant-cane stands to begin with, followed by extensive first-stubble failure, the second stubble may become so gappy as to render the cultivation of it uneconomical. This was very often the case with the previously cultivated P. O. J. varieties, 234, 213, 36, and 36–M. On the other hand, the more vigorous varieties now cultivated, such as Co. 290, C. P. 807, C. P. 28/19, C. P. 28/11, and C. P. 29/320, because of better initial stands usually obtained and also because of their greater resistance as a group to agencies responsible for stubble failure, will ordinarily produce a very satisfactory second-stubble crop.

The studies herein reported were undertaken with the twofold purpose of determining (1) the extent of gaps found in different varieties now grown in Louisiana under representative soil and weather conditions over a period of years, and (2) the extent to which gaps of various lengths will cause reductions in yields of cane and sugar per acre.

GAP MEASUREMENTS

Gaps are more readily discernible in some varieties than in others, depending largely on the growth habits of the variety. An erect-

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growing variety like Co. 281 gives the appearance of having a larger percentage of gaps than actually exists, while the opposite is true of more recumbent types, such as Co. 290. A casual observation may, therefore, lead to an erroneous estimation of the extent of gaps in a field of sugarcane. This is especially true when the observer faces in the direction of the rows.

Studies to determine the extent of gaps ordinarily occurring under typical Louisiana conditions were conducted during 1931–37 in connection with replicated variety tests at a number of cooperating plantations on soils representative of the principal types of the sugarcane district. Actual measurements were made of the gaps found in plant cane and first stubble in each case and also in the second stubble where the latter was kept in cultivation. For the purpose of this study all empty spaces of 18 inches or more in length were considered as gaps. A rod graduated at intervals of 6 inches, as illustrated in figure 1, was used for measuring gaps of 6 feet or less. Longer gaps were measured by means of a tape measure.

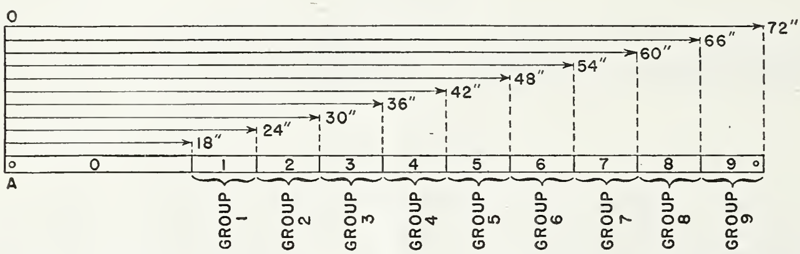

FIGURE 1.—Diagram showing graduation of rod used to measure gaps grouped at intervals of 6 inches.

In recording the gaps found in any given case, a distribution of the total into the various length groups was made as shown in table 1. The scope of this report does not permit inclusion of all such data in detail, and the tabular presentations are therefore confined to total percentages of gaps observed in individual variety measurements. An examination of the basic data has shown, however, that there is a definite relationship between the total percentage of linear row footage in gaps and the average length per gap. This is indicated by the averages given in table 2 and graphically summarized in figure 2. In general, when the total percentages of linear row footage in gaps ranged from 1 to 10, the average length per gap ranged around 2.2 feet. When the percentages ranged from 35 to 45, the average length per gap increased to approximately 3 feet, thus indicating that even with such a high percentage of gaps relatively short ones predominated. With additional increases in the percentages of linear row footage in gaps the average length per gap increased rapidly, as indicated by the fact that when the total ranged from 60 to 70 the average length per gap approached 5 feet.

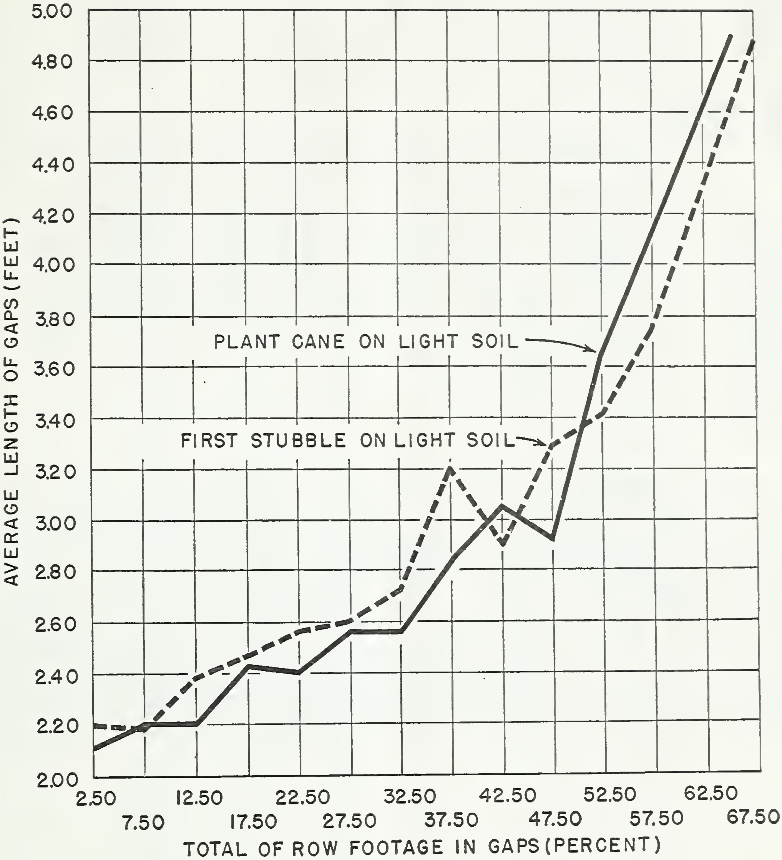

FIGURE 2.—Relation between the total percentage of row footage in gaps and the average length per gap.

TABLE 1.—*Gaps observed in a plant-cane variety test on light soil, Alma plantation, Lakeland, La., June 30, 1931, and their distribution as to length groups*

Variety	Linear row footage in gaps										
	Group 1, average length 1.75 feet	Group 2, average length 2.25 feet	Group 3, average length 2.75 feet	Group 4, average length 3.25 feet	Group 5, average length 3.75 feet	Group 6, average length 4.25 feet	Group 7, average length 4.75 feet	Group 8, average length 5.25 feet	Group 9, average length 5.75 feet	Over 6.00 feet	Total
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
P. O. J. 36-M	7.0	5.0	3.3	1.6	0.8	0.4	0.5	----	----	----	18.6
P. O. J. 213	4.2	5.7	4.7	4.3	5.3	2.8	2.6	5.0	5.8	27.5	67.9
P. O. J. 234	6.7	4.1	1.8	1.5	.6	.6	----	----	----	.4	15.7
Co. 281	7.2	4.5	2.5	1.3	.8	.2	.2	----	.3	----	17.0
Co. 290	3.2	2.7	1.8	1.2	1.0	1.2	----	----	----	.7	11.8
C. P. 807	2.3	1.5	.1	.7	.2	.4	.5	----	----	----	5.7

TABLE 2.—*Relation between extensiveness of gaps and average length per gap as observed with plant cane of several important sugarcane varieties*

Percentage of linear row footage in gaps of all lengths	Average length of gaps										
	P. O. J. 36–M	P. O. J. 213	P. O. J. 234	Co. 281	Co. 290	C. P. 28/11	C. P. 28/19	C. P. 807	C. P. 29/320	C. P. 29/116	Average
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
1.00–5.00	—	—	—	2. 15	2. 05	2. 27	2. 12	2. 12	2. 01	2. 03	2. 11
5.01–10.00	—	—	2. 21	2. 16	2. 15	2. 29	2. 19	2. 16	2. 27	2. 18	2. 20
10.01–15.00	2. 30	—	2. 05	2. 20	2. 31	2. 28	2. 32	2. 27	2. 23	1. 82	2. 20
15.01–20.00	2. 43	—	2. 44	2. 29	—	2. 56	2. 31	2. 47	2. 41	—	2. 42
20.01–25.00	2. 28	—	2. 47	2. 36	2. 36	2. 54	2. 47	2. 47	2. 25	2. 35	2. 39
25.01–30.00	2. 37	2. 52	2. 76	2. 64	2. 78	2. 57	2. 37	2. 58	2. 44	—	2. 56
30.01–35.00	2. 48	2. 63	—	2. 57	2. 60	—	2. 54	2. 56	2. 52	—	2. 56
35.01–40.00	2. 79	2. 93	—	—	2. 81	—	—	—	—	2. 82	2. 84
40.01–45.00	2. 78	3. 13	3. 20	—	—	3. 09	3. 24	—	2. 80	—	3. 04
45.01–50.00	—	3. 06	—	2. 78	—	—	—	—	—	—	2. 92
50.01–55.00	3. 36	3. 26	—	—	4. 24	—	—	—	—	—	3. 62
55.01–60.00	—	—	—	—	—	—	—	—	—	—	—
60.01–65.00	—	—	4. 75	—	—	—	—	—	—	—	4. 75
65.01–70.00	—	5. 06	—	—	—	—	—	—	—	—	5. 06

Tables 3 and 4 give the results of gap measurements made in five series of tests on light soils. In each series the studies extended over the 3 usual crop years; i. e., plant, first stubble, and second stubble. It will be noted that in a few individual tests in each series data for second stubble are not given. These were instances where in keeping with prevailing local practices the second stubble was not kept in cultivation. In showing series averages, it was, therefore, necessary to show two sets of values; (1) that for plant cane and first stubble based on all tests, and (2) that for plant cane, first stubble, and second stubble based on such of the tests as extended over the 3 crop years.

TABLE 3.—*Total percentage of row footage in gaps of 18 inches or above in plant cane, first stubble, and second stubble of variety tests on light soil at various locations in Louisiana, 1931–37*

Variety	Greenwood			Raceland			Bayou Sale			Oakland			Alma			Albania		
	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant[1] cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble
1931 SERIES (PLANT CANE, 1931; FIRST STUBBLE, 1932; SECOND STUBBLE, 1933)																		
P. O. J. 36-M	29.5	31.3	39.0	26.9	24.5	47.9	14.6	36.6	...	31.2	22.0	...	18.6	31.0	64.2	...	...	...
P. O. J. 213	33.1	31.4	45.6	37.9	29.6	67.5	44.6	49.7	...	51.0	37.3	...	67.9	68.3	86.9	...	...	...
P. O. J. 234	11.6	17.8	54.0	26.1	15.3	78.8	10.3	29.5	...	27.6	24.9	...	15.7	28.4	87.9	...	...	...
C. P. 807	3.4	2.4	4.8	6.8	3.2	6.1	4.8	5.9	...	20.3	8.4	...	5.7	9.4	21.1	...	...	...
Co. 281	13.8	23.3	30.7	14.5	9.6	21.2	9.6	30.0	...	32.8	20.1	...	17.0	30.0	61.6	...	...	...
Co. 290	7.4	7.3	6.1	10.6	10.4	11.5	7.4	16.0	...	20.3	17.5	...	11.8	22.1	33.5	...	...	...
1932 SERIES (PLANT CANE, 1932; FIRST STUBBLE, 1933; SECOND STUBBLE, 1934)																		
P. O. J. 36-M	39.2	25.9	42.1	33.2	24.1	29.1	...	...	...	27.8	49.1	...	51.0	46.1	48.1	28.7	46.0	83.9
P. O. J. 213	27.2	17.0	33.4	40.4	34.9	33.0	...	...	...	43.2	58.5	...	53.3	46.8	52.9	38.7	46.7	68.0
P. O. J. 234	25.3	22.5	70.4	26.8	31.0	53.5	...	...	...	26.5	53.0	...	62.9	62.9	81.5	11.2	43.6	69.1
Co. 281	21.4	14.1	24.1	24.3	23.8	38.3	...	...	...	15.2	20.0	...	25.6	33.6	42.7	9.7	28.0	47.7
Co. 290	9.4	5.3	4.6	9.9	6.7	8.6	...	...	...	9.9	11.3	...	14.2	11.7	14.7	7.9	9.7	13.1
C. P. 807	12.2	4.4	7.1	10.0	5.7	6.7	...	...	...	5.7	4.8	...	11.4	10.9	20.7	11.3	9.4	21.8
1933 SERIES (PLANT CANE, 1933; FIRST STUBBLE, 1934; SECOND STUBBLE, 1935)																		
P. O. J. 213	54.5	37.5	66.6	50.6	42.0	76.6	...	...	...	49.9	60.2	...	36.8	32.6	89.7	26.9	36.2	83.6
P. O. J. 36-M	50.5	30.9	59.7	32.3	25.5	66.2	...	...	...	41.5	45.2	...	29.4	16.3	44.7	26.8	22.5	82.3
Co. 281	29.1	20.3	42.3	13.0	10.2	40.4	...	...	...	19.1	20.1	...	25.4	16.9	26.8	9.9	21.6	52.6
Co. 290	7.8	7.3	7.4	9.8	3.7	6.5	...	...	...	24.4	20.6	...	11.9	9.2	24.0	8.4	9.2	21.6
C. P. 28/19	17.4	11.8	38.0	20.8	15.4	32.4	...	...	...	20.7	18.9	...	23.6	15.2	29.8	17.4	18.9	35.0
C. P. 807	10.9	3.5	23.1	18.8	6.6	17.8	...	...	...	25.4	19.5	...	15.3	10.2	27.2	4.4	4.3	23.9

See footnotes on p. 7.

TABLE 3.—*Total percentage of row footage in gaps of 18 inches or above in plant cane, first stubble, and second stubble of variety tests on light soil at various locations in Louisiana, 1931–37*—Continued

1934 SERIES (PLANT CANE, 1934; FIRST STUBBLE, 1935; SECOND STUBBLE, 1936)

Variety	Greenwood			Raceland			Bayou Sale			Oakland			Alma			Albania		
	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble
P. O. J. 234	16.9	42.2	70.2	22.8	31.1	60.0				30.7	69.6		14.6	39.0	63.6	19.3	54.1	
Co. 281	11.0	18.8	31.3	7.6	5.9	20.2				18.9	25.5		25.3	30.3	36.2	13.2	26.0	
Co. 290	4.9	5.9	15.5	3.5	4.6	8.7				11.3	15.5		13.8	11.1	13.9	5.3	10.3	
C. P. 807	6.9	4.5	10.7	1.2	1.2	5.3				9.8	10.5		12.7	12.2	20.8	9.6	11.9	
C. P. 28/11	11.2	9.0	14.1	11.6	9.3	13.5				14.6	16.1		19.5	15.6	10.3	14.5	21.9	
C. P. 28/19	13.9	16.9	27.9	11.1	10.5	17.3				18.0	23.5		16.8	21.9	23.6	22.8	30.3	

1935 SERIES (PLANT CANE, 1935; FIRST STUBBLE, 1936; SECOND STUBBLE, 1937)

Variety	Greenwood			Raceland			Bayou Sale			Oakland			Alma			Albania		
	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble
Co. 281	15.7	23.7	14.0	17.9	21.6	15.0				31.6	30.8	32.8	31.9	33.0	72.2	5.7	38.1	
Co. 290	4.6	7.5	2.6	6.4	5.8	2.9				37.4	21.7	20.7	11.4	9.5	25.4	7.7	13.8	
C. P. 807	10.9	10.1	6.5	7.4	6.3	3.0				21.8	9.1	11.1	12.3	5.3	34.8	9.2	14.2	
C. P. 28/11	14.9	15.5	8.9	14.9	13.7	12.8				28.4	13.7	13.6	26.1	20.5	44.9	7.5	21.2	
C. P. 28/19	21.2	20.5	15.4	13.5	11.4	5.8				29.5	19.6	22.4	19.1	12.9	31.8	13.6	33.5	
C. P. 29/320	25.2	24.2	13.0	29.2	19.6	12.1				34.5	22.9	21.7	17.4			10.3	9.3	

1931 SERIES (PLANT CANE, 1931; FIRST STUBBLE, 1932; SECOND STUBBLE, 1933)

Variety	Erath			L. J. Landry [2]			S. L. I.[3]			Rosewood			Average of 5 tests			Average of 3 tests [4]		
	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble
P. O. J. 36–M													24.2	29.1		25.0	28.9	50.4
P. O. J. 213													46.9	43.3		46.3	43.1	66.7
P. O. J. 234													18.3	23.2		17.8	20.5	73.6
C. P. 807													8.2	5.9		5.3	5.0	10.7
Co. 281													17.5	22.6		15.1	21.0	37.8
Co. 290													11.5	14.7		9.9	13.3	17.0

1932 SERIES (PLANT CANE, 1932; FIRST STUBBLE, 1933; SECOND STUBBLE, 1934)

													Average of 6 tests			Average of 4 tests [5]		
P. O. J. 36-M	25.0	37.8	------	------	------	------	------	------	------	------	------	------	34.1	38.2	------	38.0	35.5	50.8
P. O. J. 213	26.5	43.5	------	------	------	------	------	------	------	------	------	------	38.2	41.2	------	39.9	36.3	46.8
P. O. J. 234	22.9	55.8	------	------	------	------	------	------	------	------	------	------	29.3	44.8	------	31.5	40.0	68.6
Co. 281	23.9	37.3	------	------	------	------	------	------	------	------	------	------	20.0	26.1	------	20.2	24.9	38.2
Co. 290	8.0	9.8	------	------	------	------	------	------	------	------	------	------	9.9	9.1	------	10.3	8.3	10.2
C. P. 807	6.6	5.7	------	------	------	------	------	------	------	------	------	------	9.5	6.8	------	11.2	7.6	14.1

1933 SERIES (PLANT CANE, 1933; FIRST STUBBLE, 1934; SECOND STUBBLE, 1935)

													Average of 6 tests			Average of 4 tests [5]		
P. O. J. 213	37.7	55.4	------	------	------	------	------	------	------	------	------	------	42.7	44.0	------	42.2	37.1	79.1
P. O. J. 36-M	51.4	65.5	------	------	------	------	------	------	------	------	------	------	38.6	34.3	------	34.7	23.8	63.2
Co. 281	32.3	37.1	------	------	------	------	------	------	------	------	------	------	21.5	21.0	------	19.3	17.2	40.5
Co. 290	25.5	27.6	------	------	------	------	------	------	------	------	------	------	14.6	12.9	------	9.5	7.3	14.9
C. P. 28/19	22.3	25.0	------	------	------	------	------	------	------	------	------	------	20.4	17.5	------	19.8	15.3	33.8
C. P. 807	19.8	17.9	------	------	------	------	------	------	------	------	------	------	15.8	10.3	------	12.3	6.1	23.0

1934 SERIES (PLANT CANE, 1934; FIRST STUBBLE, 1935; SECOND STUBBLE, 1936)

													Average of 8 tests [6]			Average of 5 tests [7]		
P. O. J. 234	21.5	59.8	72.8	54.1	------	------	------	------	------	6.4	4.7	4.5	23.3	42.9	------	16.4	35.4	54.2
Co. 281	10.6	22.3	43.0	22.1	51.2	------	------	------	------	19.0	12.2	24.4	16.0	24.0	------	14.7	17.9	31.0
Co. 290	7.1	8.0	7.3	14.8	29.3	------	------	------	------	5.3	3.9	3.1	8.2	11.1	------	6.9	6.7	9.7
C. P. 807	6.5	6.8	5.7	30.0	42.9	------	------	------	------	6.9	4.0	4.4	10.4	11.7	------	6.8	5.7	9.4
C. P. 28/11	17.7	22.3	25.8	22.9	30.6	------	------	------	------	22.5	12.1	10.7	16.8	17.1	------	16.5	13.7	14.9
C. P. 28/19	15.2	13.5	19.2	26.0	32.8	------	------	------	------	8.7	4.7	8.3	16.6	19.3	------	13.1	13.5	19.3

[1] Beetle damage severe.
[2] Plantation located near New Iberia.
[3] Experimental fields, Southwestern Louisiana Institute, Lafayette.
[4] Greenwood, Raceland, Alma.
[5] Greenwood, Raceland, Albania, Alma.
[6] Except in the case of first stubble for P. O. J. 234, where the average is for 7 tests.
[7] Greenwood, Raceland, Erath, Alma, Rosewood.

TABLE 3.—*Total percentage of row footage in gaps of 18 inches or above in plant cane, first stubble, and second stubble of variety tests on light soil at various locations in Louisiana, 1931–37*—Continued

1935 SERIES (PLANT CANE, 1935; FIRST STUBBLE, 1936; SECOND STUBBLE, 1937)

Variety	Erath			L. J. Landry			S. L. I.			Rosewood			Average of 5 tests			Average of 3 tests		
	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble
													Average of 9 tests			Average of 4 tests [8]		
Co. 281	15.5	32.1	25.8	13.5	47.3	----	31.9	44.1	----	2.3	24.8	----	18.4	32.8	----	20.2	27.0	21.9
Co. 290	7.3	8.4	7.8	6.6	7.4	----	22.4	25.3	----	3.3	5.4	----	11.9	11.6	----	13.9	10.8	8.5
C. P. 807	14.1	7.4	6.1	17.4	23.2	----	19.2	23.1	----	2.1	7.8	----	12.7	11.8	----	13.5	8.2	6.7
C. P. 28/11	9.7	11.8	12.1	11.9	14.0	----	22.1	29.8	----	4.8	4.3	----	15.6	16.1	----	17.0	13.7	11.8
C. P. 28/19	5.8	4.8	4.3	10.4	25.2	----	19.2	42.9	----	8.4	15.5	----	15.6	20.7	----	17.5	14.1	12.0
C. P. 29/320	8.3	5.1	3.3	11.5	9.2	----	23.8	27.5	----	2.5	----	----	----	----	----	24.3	17.9	12.5

[8] Greenwood, Raceland, Oaklawn, Erath.

TABLE 4.—*Summary of gap measurements in connection with sugarcane variety tests on light soils in Louisiana during 1931–35 (average of all tests extending over plant cane, first stubble, and second stubble)*

Variety	Average percentage of linear row footage in gaps of 18 inches or longer																	
	1931 series [1]			1932 series			1933 series			1934 series			1935 series			Average of 5 series		
	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble	Plant cane	First stubble	Second stubble
P. O. J. 36-M	25.0	28.9	50.4	38.0	35.5	50.8	34.7	23.8	63.2	----	----	----	----	----	----	----	----	----
P. O. J. 213	46.3	43.1	66.7	39.9	36.3	46.8	42.2	37.1	79.1	----	----	----	----	----	----	----	----	----
P. O. J. 234	17.8	20.5	73.6	31.5	40.0	68.6	----	----	----	16.4	35.4	54.2	----	----	----	----	----	----
Co. 281	15.1	21.0	37.8	20.2	24.9	38.2	19.3	17.2	40.5	14.7	17.9	31.0	20.2	27.0	21.9	17.9	21.6	33.9
Co. 290	9.9	13.3	17.0	10.3	8.3	10.2	9.5	7.3	14.9	6.9	6.7	9.7	13.9	10.8	8.5	10.1	9.3	12.1
C. P. 807	5.3	5.0	10.7	11.2	7.6	14.1	12.3	6.1	23.0	6.8	5.7	9.4	13.5	8.2	6.7	9.8	6.5	12.8
C. P. 28/19	----	----	----	----	----	----	19.8	15.3	33.8	13.1	13.5	19.3	17.5	14.1	12.0	----	----	----
C. P. 28/11	----	----	----	----	----	----	----	----	----	16.5	13.7	14.9	17.0	13.7	11.8	----	----	----
C. P. 29/320	----	----	----	----	----	----	----	----	----	----	----	----	24.3	17.9	12.5	----	----	----

[1] Plant cane 1931, first stubble 1932, second stubble 1933.

The results show striking differences between the different varieties in the extent of gaps originating in both plant cane and stubble crops. Gaps in plant cane of the P. O. J. varieties 36–M, 213, and 234 frequently ranged from approximately 30 to in excess of 50 percent of the total row space, while those in the C. P. and Co. varieties rarely exceeded 25 and, in general, were greatly below 20 percent.

With Co. 281, C. P. 28/19, and C. P. 28/11 the annual average percentages of gaps in plant cane ranged between 13.1 and 20.2 percent, while in the case of the more vigorous varieties Co. 290 and C. P. 807 the corresponding values ranged from 5.3 to 13.9 percent, and were below 11 in most instances.

In comparing results obtained with individual varieties in the various localities during the same year, and in the same locality over a period of years, rather striking variations indicated that conditions under which plantings are made greatly influence the extent of gaps occurring in a given variety. While no special attempt was made in connection with these studies to determine the causes of all observed gaps, some of the important factors involved that have incidentally come to attention will be discussed later in this report.

As indicated in table 3, the gap measurements were first made on plant cane and then repeated on the identical areas during first- and second-stubble years. This procedure insured an accurate record of the extent of gaps in plant cane and of the incidence or disappearance of gaps during each of the stubble crops.

The percentage of gaps in P. O. J. 234 usually increased with each succeeding crop from a given planting, but with most of the other varieties the percentage of gaps in first stubble ordinarily was not significantly higher than in the preceding plant cane and quite often it was measurably lower. The latter condition was particularly noticeable in such vigorous varieties as Co. 290 and was caused, no doubt, from the spreading of stools of cane having reduced the lengths of the gaps.

All varieties showed a rather consistent tendency for an increase in the percentage of gaps in second stubble over that in first stubble, but here again individual varieties displayed wide variations among themselves. Co. 290 and C. P. 807, in the average of 5 yearly series of plantings made consecutively during the period 1931–35 (table 4) and involving 20 individual plantings at 5 localities, showed a lower percentage of gaps in the first stubble and a higher percentage in the second stubble than in the plant cane, whereas Co. 281 showed an increasing percentage in the first stubble and in the second stubble over that in the plant cane. Other varieties studied were not included in tests during the entire period, and because of seasonal differences the observed percentages of gaps are not strictly comparable to the above.

Table 5 shows yearly averages for the percentage of gaps observed in the plant cane of different varieties in tests on heavy-soil areas during 1931–37. In line with common plantation experience, all varieties tested showed consistently higher percentages of gaps on heavy soils than in comparable plantings on light soils. In the low-lying compact soils of the first-mentioned group, the influence of factors responsible for germination failures is usually much greater than in the light soils. Under conditions of excessive rainfall, red

rot damage (*1*) [1] is much more severe, especially with susceptible varieties, while under excessively dry conditions it is extremely difficult to prepare a satisfactory seedbed.

As shown by the results represented in figure 3, based upon observations made on all of the tests on heavy soils that extended over plant cane, first stubble, and second stubble, there was a consistent decrease in the percentage of gaps in first stubble as compared with

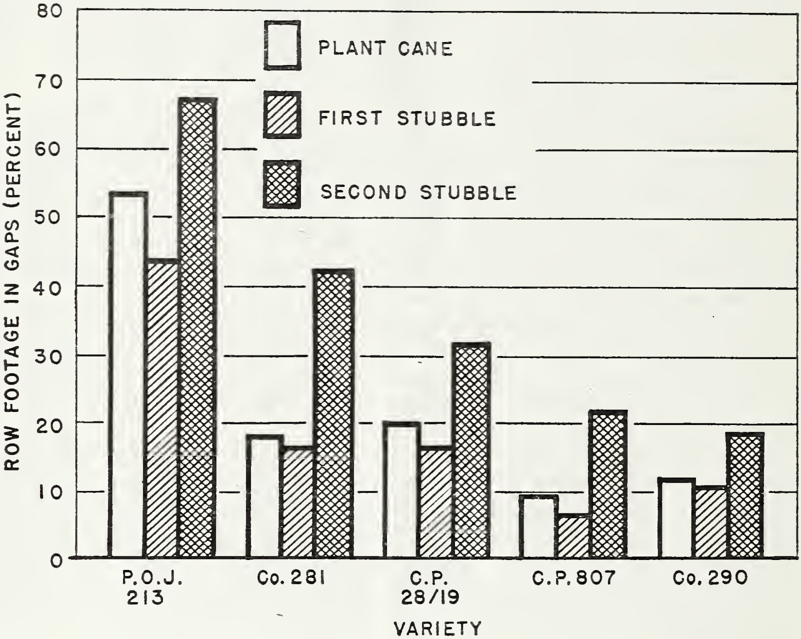

FIGURE 3.—Graphic summary of results of gap measurements in plant cane, first stubble, and second stubble of variety tests on heavy soil in Louisiana during 1931, 1932, 1934, and 1935.

that observed in the preceding plant cane followed by a very decided increase in second stubble. Under these conditions the occurrence of gaps in second stubble was usually much greater than observed with the same variety on light-soil areas due, no doubt, to the effects of the unfavorable soil conditions on the extent of stubble deterioration.

TABLE 5.—*Summary of results of gap measurements in plant-cane variety tests on heavy soil in Louisiana during 1931–37*

Variety	Average total percentage of row footage in gaps of 18 inches						
	1931	1932	1933	1934	1935	1936	1937
P. O. J. 213	53. 1						
P. O. J. 234			50. 7				
Co. 281	20. 2	19. 0	27. 3	14. 8			
Co. 290		13. 7	25. 9	9. 3	22. 3	39. 9	20. 1
C. P. 807	9. 2	9. 3	19. 5	9. 8	16. 5	50. 8	23. 9
C. P. 28/19				19. 7	20. 6	73. 0	44. 3
C. P. 28/11					17. 8		24. 4
C. P. 29/116							14. 0

[1] Italic numbers in parentheses refer to Literature Cited, p. 20.

CONTROLLED EXPERIMENTS TO DETERMINE YIELD LOSSES DUE TO GAPS

In estimating the economic importance of gaps in sugarcane, it should be recognized that the resultant loss in yield does not necessarily equal the proportionate yield that might have been secured from the vacant spaces. It may be assumed that there would be some compensatory growth on the part of plants adjoining the vacant spaces, depending on their ability to utilize the additional sunlight, plant food, and moisture, and that the losses resulting from gaps would not be equivalent to the percentage of the row space occupied by them. In an attempt to measure the influence of gaps of different lengths on yields of cane and sugar under Louisiana conditions controlled experiments were conducted with several sugarcane varieties, detailed results of which are given in table 6 and summarized in table 7. The object in each case was to measure the yields of cane per acre, sugar per ton of cane, and sugar per acre from a series of plots without any gaps of plant-cane origin, in comparison with yields from plots with 50 percent of the row space in gaps of uniform length.

TABLE 6.—*Results of experiments to determine the influence of gaps of various lengths on yields of cane and sugar with several important varieties of sugarcane under Louisiana conditions*

TESTS WITH CO. 281

Series and time of planting	Length of artificially made gaps covering 50 percent of row space	Plant cane: Yield of cane per acre	Plant cane: Indicated yield of 96° sugar, Per ton of cane	Plant cane: Indicated yield of 96° sugar, Per acre	First stubble: Yield of cane per acre	First stubble: Indicated yield of 96° sugar, Per ton of cane	First stubble: Indicated yield of 96° sugar, Per acre	Second stubble: Yield of cane per acre	Second stubble: Indicated yield of 96° sugar, Per ton of cane	Second stubble: Indicated yield of 96° sugar, Per acre
	Inches	*Tons*	*Pounds*	*Pounds*	*Tons*	*Pounds*	*Pounds*	*Tons*	*Pounds*	*Pounds*
Series 1, planted during fall of 1930.	20	23.83	154.5	3,682	16.85	201.9	3,402	(1)	(1)	(1)
	30	21.45	153.6	3,295	18.20	201.9	3,675	(1)	(1)	(1)
	40	21.19	153.1	3,244	16.09	202.8	3,263	(1)	(2)	(1)
	60	20.43	152.1	3,107	17.05	202.8	3,458	(1)	(1)	(1)
	Check [2]	27.47	163.1	4,480	19.62	200.5	3,934	(1)	(1)	(1)
Series 2, planted during fall of 1931.	20	35.92	213.7	7,676	26.33	219.6	5,782	(1)	(1)	(1)
	30	36.96	214.4	7,924	26.74	220.5	5,896	(1)	(1)	(1)
	40	36.05	213.5	7,697	27.27	219.8	5,994	(1)	(1)	(1)
	60	34.95	206.5	7,217	26.93	219.4	5,908	(1)	(1)	(1)
	Check [2]	41.28	220.4	9,098	27.80	218.2	6,066	(1)	(1)	(1)
Series 3, planted during fall of 1932.	30	25.08	220.8	5,538	29.65	210.8	6,250	27.38	181.5	4,969
	60	21.58	213.6	4,609	25.99	212.3	5,518	26.25	176.5	4,633
	120	21.50	217.4	4,674	23.08	213.9	4,937	25.76	183.1	4,717
	Check [2]	28.86	219.9	6,346	32.29	197.2	6,368	26.18	172.7	4,521
Series 4, planted during fall of 1933.	15	25.17	228.9	5,761	35.07	189.7	6,653	22.70	148.2	3,364
	30	21.52	241.2	5,191	35.38	184.4	6,524	23.09	152.1	3,512
	60	18.57	243.1	4,514	30.01	181.8	5,456	19.72	139.7	2,755
	120	17.97	233.7	4,200	29.26	189.8	5,554	18.31	131.7	2,411
	Check [2]	26.72	248.6	6,643	36.48	192.7	7,030	23.23	147.6	3,429

TESTS WITH C. P. 807

Series and time of planting	Length of gaps	Plant cane: Yield	Plant cane: Per ton	Plant cane: Per acre	First stubble: Yield	First stubble: Per ton	First stubble: Per acre	Second stubble: Yield	Second stubble: Per ton	Second stubble: Per acre
Series 2, planted during fall of 1931.	20	41.59	187.8	7,811	34.55	185.4	6,406	(1)	(1)	(1)
	30	37.58	180.8	6,794	33.53	187.2	6,277	(1)	(1)	(1)
	40	38.93	190.5	7,416	33.76	190.4	6,428	(1)	(1)	(1)
	60	36.41	181.8	6,619	33.83	195.7	6,621	(1)	(1)	(1)
	Check [2]	42.87	192.0	8,231	33.95	193.2	6,559	(1)	(1)	(1)
Series 3, planted during fall of 1932.	30	29.46	190.3	5,606	34.40	172.3	5,927	28.42	152.7	4,340
	60	29.57	191.2	5,654	35.61	169.3	6,029	28.54	155.1	4,427
	120	28.55	192.0	5,482	32.59	181.7	5,922	27.67	158.4	4,383
	Check [2]	36.36	197.3	7,174	35.95	178.4	6,413	28.04	153.9	4,315
Series 4, planted during fall of 1933.	15	30.80	163.0	5,020	42.72	175.6	7,502	27.92	130.7	3,649
	30	28.80	172.0	4,954	42.41	177.0	7,507	26.54	127.3	3,379
	60	27.21	170.5	4,639	41.27	150.2	6,199	25.88	130.9	3,388
	120	25.78	160.4	4,135	38.72	167.9	6,501	23.80	128.9	3,068
	Check [2]	32.88	175.6	5,774	43.87	167.5	7,348	28.07	135.0	3,789

See footnotes at end of table.

TABLE 6.—*Results of experiments to determine the influence of gaps of various lengths on yields of cane and sugar with several important varieties of sugarcane under Louisiana conditions*—Continued

TESTS WITH P. O. J. 234

Series and time of planting	Length of artificially made gaps covering 50 percent of row space	Plant cane			First stubble			Second stubble		
		Yield of cane per acre	Indicated yield of 96° sugar		Yield of cane per acre	Indicated yield of 96° sugar		Yield of cane per acre	Indicated yield of 96° sugar	
			Per ton of cane	Per acre		Per ton of cane	Per acre		Per ton of cane	Per acre
	Inches	*Tons*	*Pounds*	*Pounds*	*Tons*	*Pounds*	*Pounds*	*Tons*	*Pounds*	*Pounds*
Series 1, planted during fall of 1930.	20	18.51	177.2	3,280	18.74	203.3	3,810	[1]	[1]	[1]
	30	19.65	176.8	3,474	18.46	203.7	3,760	[1]	[1]	[1]
	40	18.42	170.3	3,137	18.64	206.3	3,845	[1]	[1]	[1]
	60	18.40	178.1	3,277	17.69	210.9	3,731	[1]	[1]	[1]
	Check [2]	21.20	190.1	4,030	19.05	205.0	3,905	[1]	[1]	[1]
Series 2, planted during fall of 1931.	20	25.52	176.1	4,494	22.18	219.0	4,857	[1]	[1]	[1]
	30	23.91	188.2	4,500	23.42	215.8	5,054	[1]	[1]	[1]
	40	22.94	162.5	3,728	22.44	220.4	4,946	[1]	[1]	[1]
	60	22.51	180.9	4,072	22.78	216.5	4,932	[1]	[1]	[1]
	Check [2]	27.15	189.0	5,131	24.10	226.1	5,449	[1]	[1]	[1]

TESTS WITH CO. 290

Series and time of planting	Length of gaps	Plant cane: Yield of cane per acre	Per ton of cane	Per acre	First stubble: Yield of cane per acre	Per ton of cane	Per acre	Second stubble: Yield of cane per acre	Per ton of cane	Per acre
Series 4, planted during fall of 1933.	15	36.17	224.7	8,127	49.50	181.9	9,004	34.37	139.5	4,795
	30	33.09	217.5	7,197	45.94	182.2	8,370	31.87	138.8	4,424
	60	32.38	220.3	7,133	45.98	179.1	8,235	32.81	148.5	4,872
	120	29.66	215.7	6,398	44.70	183.0	8,180	32.25	137.3	4,428
	Check [2]	36.96	215.3	7,957	47.61	183.8	8,751	34.11	144.5	4,929

[1] Results from second stubble not obtained.
[2] No artificially made gaps.

TABLE 7.—*Summary of results of all gap tests with Co. 281, C. P. 807, and Co. 290 given in table 6*

AVERAGE RELATIVE YIELD OF SUGAR PER ACRE [1]

Length of artificially made gaps (inches)	Plant cane			First stubble			Second stubble			Total of 3 crops		
	Co. 281	C. P. 807	Co. 290	Co. 281	C. P. 807	Co. 290	Co. 281	C. P. 807	Co. 290	Co. 281	C. P. 807	Co. 290
15–20 percent	84.7	91.6	102.1	93.0	100.0	102.9	98.1	96.3	97.3	91.0	95.9	101.3
30–40 do	81.9	84.2	90.4	94.6	97.2	95.6	106.7	95.2	89.8	92.7	91.6	92.4
60 do	73.2	79.9	89.6	86.9	92.8	94.1	92.9	96.4	98.8	83.1	88.7	93.5
120 do	63.3	74.3	80.4	78.3	90.3	93.5	89.7	91.9	89.8	77.7	84.8	87.8

COMPUTED YIELD-REDUCTION FACTOR FOR SUGAR PER ACRE [2]

Length of artificially made gaps (inches)	Plant cane: Co. 281	C. P. 807	Co. 290	First stubble: Co. 281	C. P. 807	Co. 290	Second stubble: Co. 281	C. P. 807	Co. 290	Total of 3 crops: Co. 281	C. P. 807	Co. 290
15–20	0.306	0.168	[3] 0.042	0.140	0.0	[3] 0.058	0.038	0.074	0.054	0.180	0.082	[3] 0.026
30–40	.362	.316	.192	.108	.056	.088	.134	.096	.204	.146	.168	.152
60	.536	.402	.208	.262	.144	.118	.142	.072	.024	.338	.226	.130
120	.734	.514	.392	.434	.194	.130	.206	.162	.204	.446	.304	.244

[1] Average yield from corresponding check plots without any artificially made gaps taken as 100.
[2] Reduction in yield attributable to gaps divided by the normally expected yield from the row footage in the gaps involved. See text for further discussion.
[3] Yield insignificantly higher than from check.

Each individual test usually consisted of a 5 by 5 Latin square with individual plots 16½ feet (three rows) wide and 20 feet long. This provided for four series of plots, varying among themselves as to length of gaps, in addition to a check series. At the time of planting, seed cane was omitted within the spaces intended for gaps. The gaps

which invariably comprise 50 percent of the row space were uniformly distributed over the plot area in accordance with a uniform pattern. Figure 4 illustrates a plot in which 50 percent of the row space was in gaps of uniform length of 60 inches.

It should be pointed out that in actual results the ideal objectives as to precise occurrence or absence of gaps were only approximately realized. While unusual care was exercised in the selection of seed material, preparation of seedbed, and planting of plots, occasional short gaps occurred in the plant cane of check plots, and the actual gappage in other series varied somewhat from that artificially induced in the seed lines at time of planting. This is illustrated by the results

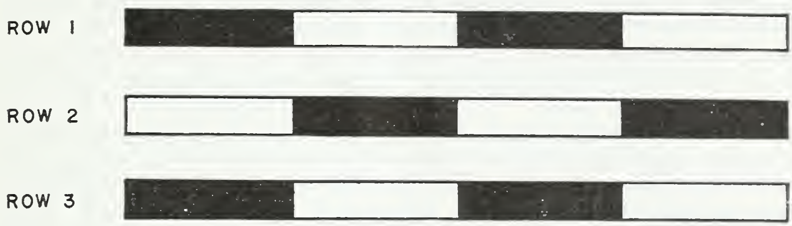

FIGURE 4.—Diagram showing distribution of 60-inch gaps (light areas) in a three-row plot 20 feet long.

of observations on plots planted during 1931, summarized in table 8, which are typical of the conditions under which the tests were conducted.

TABLE 8.—*Relationship between extent and length of artificially made gaps at time of planting and that observed in the plant-cane crop in plots of series 2 (planted during the fall of 1931)*

Artificially made gaps at time of planting		Observed gaps in plant cane					
		Tests with Co. 281		Tests with C. P. 807		Tests with P. O. J. 234	
Length of each gap (inches)	Row space occupied by gaps	Average length of gaps	Row space occupied by gaps	Average length of gaps	Row space occupied by gaps	Average length of gaps	Row space occupied by gaps
	Percent	*Inches*	*Percent*	*Inches*	*Percent*	*Inches*	*Percent*
20	50	23. 55	58. 89	18. 93	47. 33	23. 69	59. 56
30	50	31. 68	52. 81	29. 54	49. 28	32. 68	54. 47
40	50	43. 90	54. 90	39. 84	49. 81	42. 82	53. 52
60	50	62. 71	53. 33	60. 20	50. 17	65. 53	54. 56
0	0	18. 12	4. 42	20. 00	. 56	19. 23	5. 56

Since in all cases the ideal conditions were for practical purposes approximately realized, and particularly since variations in the series of gappy plots and those in the corresponding check plots were such as tended to be mutually compensatory, the differences between the various gappy series and corresponding checks should reflect rather accurately the net effects of artificially made gaps.

A statistical examination of the basic data indicates that on the whole, in individual tests, a difference of 10 percent in yield of cane per acre and of 12 percent in yield of sugar per acre between averages of different series could ordinarily be regarded as significant. General

averages shown in table 7, derived from varying numbers of individual tests, are subject to relatively higher degrees of accuracy.

As stated previously, in plots used to measure the influence of gaps, approximately one-half of the linear row footage consisted of blank spaces. If the presence of gaps had not influenced the growth of stools in adjoining areas, the plots with artificially made gaps should have yielded at the rate of approximately 50 percent of the average of plots in the corresponding series of checks. The results show quite conclusively that plots with such artificially induced gaps yielded at a rate consistently higher than 50 percent of the yield from corresponding check plots. The results show further that the extent of yield reduction to be expected from a given condition as to gaps will vary greatly with different varieties and with different crop years (plant cane, first stubble, and second stubble). Of the varieties studied, Co. 281 and P. O. J. 234 showed the largest yield reductions from gaps and Co. 290 the least. The extensive and vigorous root system of the latter variety must have been an important factor in permitting it to draw extensively from the available moisture and plant food within the gaps. Furthermore, because of characteristic growth differences, varieties such as Co. 290 and C. P. 807 will extend a more effective leaf canopy over a gap than the more erect varieties such as Co. 281. This, in addition to greatly reducing weed growth in gaps and thus conserving moisture and plant food, must result in a much more efficient utilization of sunlight in cases where extensive gaps occur.

The results of all tests, summarized in table 7, indicate very conclusively that gaps of plant-cane origin do more harm in plant cane than in any of the other succeeding crops; in fact, in the average of all tests conducted, the measurable yield reduction attributable to gaps of this class was greater in the plant cane than in the combined first- and second-stubble crops. In this connection, the observed encroachment on gaps of adjoining stools during stubble crops must have been an important factor in mitigating the adverse influence of gaps. Possible differences between plant cane and stubble in extensiveness of root development also may have played an important part.

By taking the difference between the cane or sugar yield from a series of plots with a known extent of artificially made gaps of uniform length and the corresponding yield observed in the average of checks, it is possible to arrive at an estimate of the net effects of the gaps involved. It should be mentioned, however, that the actually observed difference will be subject to random variations due to soil heterogeneity and other sources of experimental error, and the results must be interpreted in the light of such limitations.

In tests planted during the fall of 1930 (table 6), plots of Co. 281 with artificially made gaps of 20 inches comprising 50 percent of the row space yielded at the average rate of 3,682 pounds of sugar per acre as compared with an average yield of 4,480 pounds from the plots with approximately perfect stands. The difference of 798 pounds may be regarded as the net effect of the artificially made gaps in reducing the yield of sugar per acre. This is substantially less than 2,240 pounds (50 percent of 4,480 pounds), which would have been the approximate reduction had the gaps reduced the yield to the full extent of the expected normal production of the space occupied by them. Thus the relation between 798 pounds and 2,240 pounds, or

35.6 percent, may in this case be taken as a measure of the effectiveness of the gaps involved in reducing the yield in proportion to the normal production to be expected from the area involved. This will hereinafter be referred to as the "yield-reduction factor," for yield of sugar per acre. A similarly derived factor could be determined from observed values as to yield of cane per acre. In table 7 are given yield-reduction factors as applying to yield of sugar per acre for plant cane, first stubble, and second stubble, and the total of the three crops for gaps of various lengths with each of three important varieties, as based on results obtained in the average of all tests conducted.

It will be noted that in individual crop yields (plant cane, first and second stubble) as well as in the aggregate yields from the three crops there was a rather consistent increase in yield-reduction factor for sugar per acre with an increase in length of individual gaps in the case of the three varieties.

In the aggregate of the three crops, C. P. 807 showed the following yield-reduction factors for the various gap lengths mentioned: 15 to 20 inches, 0.082; 30 to 40 inches, 0.168; 60 inches, 0.226; and 120 inches, 0.304. Assuming that under conditions of a perfect stand when grown in rows spaced 6 feet apart, or 7,260 row feet per acre, the normal yield from this variety in the aggregate of plant cane, first stubble, and second stubble is 15,000 pounds of sugar per acre, or 2.066 pounds per linear row foot; on the basis of the above results a gap of 10 feet caused a loss of approximately 6.3 pounds of sugar ($10 \times 2.066 \times 0.304$). On the other hand, a gap of 1½ feet reduced the yield by only 0.25 pound. Thus a 10-foot gap caused a considerably greater yield loss than several shorter gaps making up a total of 10 feet. A more or less similar relationship was maintained in other corresponding varietal averages with rather well-defined differences between varieties as to the effect of gaps of various lengths on sugar yields. The two slight reversals in trend (0.18 for 15- to 20-inch gaps and 0.146 for 30- to 40-inch gaps in the case of Co. 281, and 0.152 for 30- to 40-inch gaps and 0.13 for 60-inch gaps in the case of Co. 290) are such as may readily be expected in view of the experimental error involved.

Assuming conditions similar to those under which the tests were conducted (and it is assumed that for practical purposes they may be taken as representative of Louisiana conditions), the results of these studies afford a basis for estimating the losses in cane and sugar yields with the varieties involved under different conditions as to prevalence and length of gaps, and also for estimating what the yield would have been with a perfect stand. However, individual calculations of yield-reduction factors due to gaps, while showing well-defined trends, are subject to certain fluctuations due to experimental variations that are obviously not associated with variations in length of gaps. It is believed, therefore, that calculated values of yield-reduction factors of different gap lengths based on the trend observed with a given variety will afford a more reliable estimate for the purpose of generalization than the corresponding values based on actual observations in each case.

Table 9 shows values of yield reduction factors for yield of sugar per acre for each of three varieties and for the average of the three, as actually observed and also as calculated by fitting a second-order parabola to the observed data, using the equation $y=a+bx+cx^2$ (7).

The generally good agreement between observed and calculated values and the Chi square test (probability 0.99 in the case of averages for three varieties) (*3*) indicate that the observed relationship is satisfactorily shown by this means. The relation between length of gap and yield-reduction factor for each of three varieties calculated as per above is graphically shown in figure 5, from which values for gaps of any length from 17.5 to 120 inches may be estimated.

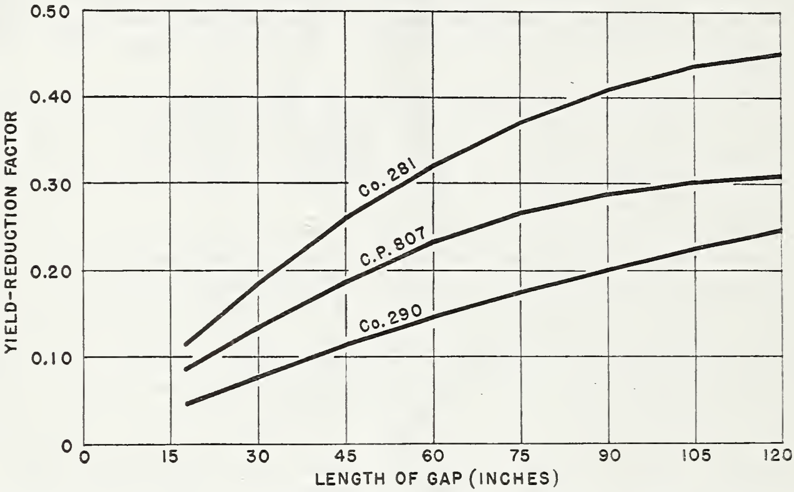

FIGURE 5.—Graphic representation of the relation between length of gap and yield-reduction factor for yield of sugar per acre (total of plant cane, first stubble, and second stubble), as determined by fitting a second-order parabola to the basic data for each of three varieties of sugarcane.

TABLE 9.—*Yield-reduction factors for yield of sugar per acre (total of plant cane and two stubble crops) applying to gaps of different lengths with different varieties of sugarcane, as observed in the results of field tests and as calculated from a second-order parabola*

Average length of gaps (inches)	Reduction factor for yield of sugar per acre							
	Computed directly from results of field tests				Calculated by fitting a second-order parabola to computed values			
	Co. 281	C. P. 807	Co. 290	Average of 3 varieties	Co. 281	C. P. 807	Co. 290	Average of 3 varieties
17.5	0.180	0.082	[1] −0.026	0.0787	0.1147	0.0852	0.0441	0.0810
35	.146	.168	.152	.1553	.2093	.1540	.0882	.1506
60	.338	.226	.130	.2313	.3183	.2311	.1443	.2313
120	.446	.304	.244	.3313	.4480	.3032	.2426	.3314

[1] Yield insignificantly higher than from control series.

An assumed field of Co. 281 showing 30 percent of gaps of plant-cane origin, each gap being 5 feet in length and a yield of 18,000 pounds of sugar per acre in the aggregate of plant cane and two stubble crops, may be used as a simple illustration of the application to field observations of yield-reduction factors as calculated above. Based on

calculated values, it may be estimated that the gaps were responsible for a reduction of 30 percent times the yield-reduction factor of 0.3183, in this case, or 9.55 percent. The observed yield may, therefore, be estimated as 90.45 percent of what it would have been with a perfect stand, and the latter, therefore, estimated at $\frac{18,000}{0.9045}$, or 19,900 pounds. The above-described calculation could be expressed in the following simple formula:

$$Y'=\frac{Y}{(1.00-G\ R)}$$

In which Y=observed yield under a given condition as to gaps.
Y'=estimated yield under conditions of perfect stand.
G=percentage of linear row footage in gaps.
R=calculated yield reduction factor applying under the conditions.

Since under actual field conditions gaps of widely different lengths will ordinarily occur in the same plot, it will be necessary to divide them into groups as to length and, therefore, as to applicable yield-reduction factor, in order to estimate accurately the resulting yield reduction. The sum of all the different groups (each expressed in terms of percent of the total row space occupied) which may be designated as G_1 G_2 G_3---- will comprise the total gap percentage observed. The yield-reduction factors corresponding to the various groups involved may be designated as R_1 R_2 R_3-----. Under these conditions the formula given above would be expressed as—

$$Y'=\frac{Y}{1-(G_1R_1+G_2R_2+G_3R_3\text{----})} \tag{2}$$

Example: A field of C. P. 807 giving total yield of 20,000 pounds of sugar per acre in the aggregate of plant cane and two stubble crops showed 32 percent of gaps in plant cane as shown below:

Group	Average length of gaps (inches)	Percentage of total row footage
A	17.5	15
B	35	10
C	60	5
D	120	2

Applying the calculated yield reduction factors for the various gap groups as given in table 9—

$$Y'=\frac{20,000}{1.00-(0.15\times 0.0852)+(0.10\times 0.1540)+(0.05\times 0.2311)+(0.02\times 0.3032)}$$

$$Y'=\frac{20,000}{1.00-0.0458}=\frac{20,000}{0.9542}=20,960$$

Thus it may be estimated that the loss of sugar per acre due to gaps in the plant cane in this particular instance was 960 pounds in the course of the three crops.

The above methods for estimating reduction in yields due to gaps relate only to losses resulting from gaps originating in plant cane and do not take account of additional gaps originating in the succeeding

stubble crops, the extent of which would vary with different varieties and under different climatic and other conditions. Gaps originating in stubble crops are undoubtedly responsible for important additional losses, but these studies related solely to the effect of gaps originating in plant cane, and no attempt was made to measure reductions in yield resulting from gaps that may have originated subsequently.

A more generalized estimate of sugar losses due to gaps of different lengths with the various varieties may be reached in the following manner: Assuming rows 6 feet wide, an acre of land comprises 7,260 row feet. The results of comparative variety tests conducted during the past 5 years indicate that under average Louisiana conditions, the following yields of sugar per acre for the aggregate of plant cane, first stubble, and second stubble may be taken as representative of the varieties mentioned under conditions of approximately perfect stands: Co. 290, 18,000 pounds; C. P. 807, 15,000 pounds; Co. 281, 12,000 pounds. Expressed in pounds of sugar per linear row feet, the yields would be: Co. 290, 2.479; C. P. 807, 2.066; Co. 281, 1.653. Thus, if a 5-foot gap in the case of Co. 281 had the same effect as entirely eliminating from production so much area, it would entail a yield loss of 8.26 pounds of sugar. This is accomplished only partially, the actual reduction being subject to what has been previously termed as a yield-reduction factor. In this particular case, based on results shown in table 9, the actual sugar loss could be estimated at 8.25×0.3183, or 2.6 pounds. In a similar manner, the estimated loss of sugar from individual gaps of various lengths has been computed for each of three important varieties, results of which are shown in table 10.

TABLE 10.—*Estimated sugar loss from individual gaps of various lengths originating in plant cane with each of three important sugarcane varieties*

Length of gap (feet)	Estimated loss of sugar per gap in the course of plant cane, first stubble, and second stubble crops		
	Co. 281	C. P. 807	Co. 290
	Pounds	*Pounds*	*Pounds*
1.5	0.3	0.3	0.2
3	1.1	1.0	.7
5	2.6	2.4	1.8
10	7.4	6.3	6.0

DISCUSSION

Data presented in this circular on yield losses due to gaps of various lengths originating in plant cane are based on results obtained from tests in which yields from plots with approximately 50 percent of the row space in gaps of known uniform length were compared with yields from plots showing perfect stands. It is possible that variations in the actual percentage of a given gap may have caused variations in the yield-reduction factor as computed. In other words, it is possible that a yield-reduction factor for a 5-foot gap based on 25-percent prevalence may differ somewhat from the factor for the same length gap based on 50-percent prevalence due to possible differences in extent of compensatory growth on the part of cane on remaining portions of the row. The scope of this work did not permit an investigation of

this particular point, but it is believed that such variations would be very slight in comparison with those related to the length of the individual gaps and that for the purpose of these studies they may probably be regarded as negligible.

While the studies show that a gap in the stand of sugarcane does not entail a yield loss equivalent to the normal production of the area involved, the annual losses in sugar yield attributable to gaps under Louisiana conditions are of sufficient importance to merit serious consideration. In the average of yearly results summarized in table 3 (averages not shown in table) the following percentages of gaps were observed in measurements involving 34 tests with each variety and extending over a period of 5 years: Co. 281, 18.7; Co. 290, 11.2; and C. P. 807, 11.3. In tests extending over a period of 3 years an average of 17.5 percent of gaps was observed in C. P. 28/19. The estimated losses in sugar per acre over the usual three crops as based on yield-reduction factors shown in table 9 ranged from 230 pounds in the case of Co. 290 to 450 pounds in the case of Co. 281. Translated in terms of plantation-scale operations, these figures must be regarded as extremely significant.

Tests on heavy clay areas (table 5) did not include the entire group of varieties tested on light soils, but wherever comparisons were available a higher percentage of gaps was observed and, by inference, greater yield losses were suffered in the case of the former.

The influence of gaps on increasing the prevalence of weed growth, with consequent increase in cost of cultivation, is another factor to be considered in connection with their economic importance. Gaps are undoubtedly an important factor in the incidence of colonies of perennial weeds, such as Johnson grass (*Sorghum halepense* (L.) Pers.), Bermuda grass (*Cynodon dactylon* (L.) Pers.), and alligatorweed (*Telanthera philoxeroides* Griseb., syn. *Alternanthera philoxeroides* Griseb.).

The principal causes of gaps as based on general observations have been mentioned in a previous publication (*2*). No special attempt was made in this study to determine all the factors responsible for gaps observed in field plantings, but it was observed incidentally that in many instances their prevalence could be traced to faulty field practices of which excessively deep planting, faulty seedbed preparation, and improper time of planting were among the outstanding ones. Poor drainage and the use of mechanical shavers on plant cane were also found to be important sources of gaps. The influence of seed rots on the occurrence of gaps under Louisiana conditions has been discussed by Abbott (*1*). Insect damage is another important source of stand deficiencies. Holloway and others (*5*) and Hinds and Osterberger (*4*) have shown that the use of sugarcane damaged by sugarcane borer (*Diatraea saccharalis* F.) gives a much lesser percentage of germinations (and as might be inferred, a larger percentage of gaps) than borer-free cane. Damage by the sugarcane beetle (*Euetheola rugiceps* Lec.) as an extensive source of gaps in certain localities has been discussed by Ingram and Bynum (*6*).

SUMMARY

A perfect stand of sugarcane is not usually obtained under normal Louisiana conditions. The extent of gaps has been found to vary widely under different conditions and with different varieties. With

the previously cultivated P. O. J. varieties, gaps in plant cane to the extent of 30 to 40 percent of the row space were generally found. As a group, the C. P. and Co. varieties now in cultivation show much lower percentages of gaps than were ordinarily found in the P. O. J. varieties, but under certain conditions even the former varieties have given very imperfect stands.

Controlled experiments have shown that the loss in sugar yield resulting from a gap of a given length is considerably less than the normal production of sugar from the area occupied by the gap, indicating that extensive compensatory growth is made by stools adjacent to gaps. The extent to which the observed loss in sugar yield from a given gap approaches the normal production of the area involved has been designated as the "yield-reduction factor." It was found that the actual value of the yield-reduction factor is significantly dependent on (1) the length of the gap, (2) the variety involved, and (3) the crop year. Short gaps were found to reduce yields much less than equivalent space in longer gaps. Among the varieties studied, Co. 281 showed the greatest relative yield loss from a given "gappage," while Co. 290 showed the least. The greatest yield loss from gaps of plant-cane origin occurred in the plant-cane crop. Average yield-reduction factors for gaps of various lengths observed with each of three important varieties, as applying to the yield of sugar per acre for plant cane, first stubble, and second stubble and for the aggregate of the three crops, are given in tabular form. A formula is suggested for estimating the loss in yield of sugar per acre from gaps under specific conditions.

Generalized values for the estimated loss in sugar per acre, under average Louisiana conditions, from individual gaps of different lengths were calculated for each of three important varieties.

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